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13. ABSTRACT *(Maximum 200 words)*

In the course of our research we have demonstrated that the ultra-wideband transient fields which scatter from a general target can be represented as a sum of wavefronts, resonances, and chirps. The latter is of particular importance for scattering from engine inlets, often the principal source of scattering from military aircraft. To date inverse algorithms have been developed based on wavefronts and resonances separately, and very little work has been directoed toward including the effects of chirps. Over the last year we have implemented a wave-based matching pursuits algorithm which incorporates all three wave objects, with application to data scattered from military aircraft. In addition to developing the algorithm per se, we have performed a detailed analysis of its performance for noisy data. Moreover, we are now applying it to data measured by the Navy laboratory in China Lake, CA, in collaboration with Brett Borden.

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Final Report

to

Dr. Arje Nachman
Air Force Office of Scientific Research (AFOSR/NM)
Air Force Office of Scientific Research
110 Duncan Avenue, Suite B115
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for

Grant: F49620-94-1-0363 (AASERT on Ultra-Wideband Electromagnetics)

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I. Objectives

Development of analytical mathematical techniques for the analysis of ultra-wideband (UWB) transient scattering and propagation in canonical environments. The results from such analyses are used subsequently in inverse schemes, to effect wave-based signal-processing algorithms.

II. Status of Effort

We have analyzed wideband scattering from canonical features on general scatterers, and have demonstrated that the diffraction coefficients from such, over a wide frequency bandwidth, can be expressed in terms of an exponential model, suitable for a Prony-like parametrization. Using this insight, we have developed model-based, superrresolution algorithms for extracting the diffraction coefficients from measured (noisy) data. Moreover, the ultimate practicality of such an approach has been examined through investigation of the Cramer-Rao lower bound, which yields the minimum SNR required to extract such features from noisy data. We have recently developed a wave-based matching pursuits algorithm which incorporates wave-scattering physics, with recent results applied to ISAR and general aircraft scattering.

III. Accomplishments/ New Findings

In the course of our research we have demonstrated that the ultra-wideband transient fields which scatter from a general target can be represented as a sum of wavefonts, resonances, and chirps. The latter is of particular importance for scattering from engine inlets, often the principal source of scattering from military aircraft. To date inverse algorithms have been developed based on wavefronts and resonances separately, and very little work has been directed toward including the effects of chirps. Over the last year we have implemented a wave-based matching pursuits algorithm which incorporates all three wave objects, with application to data scattered from military aircraft. In addition to developing the algorithm *per se*, we have performed a detailed analysis of its performance for noisy data. Moreover, we are now applying it to data measured by the Navy laboratory in China Lake, CA, in collaboration with Brett Borden.

IV. Personnel Supported

Dr. Mark McClure; US Citizen, PhD February 1998; currently employed at Lincoln Laboratory

David Fergusen, PhD Candidate (US Citizen)

V. Publications

[1] M. McClure, R. C. Qiu, and L. Carin, "On the superresolution identification of wavefronts from swept-frequency scattering data," *IEEE Trans. Antennas Prop.*, vol. AP-45, pp. 631-640, April 1997.

[2] S. Vitebskiy, L. Carin, M. Ressler and F. Le, "Ultra-wideband, short-pulse ground-penetrating radar: theory and measurement," *IEEE Trans. Geoscience and Remote Sensing,* vol. 35, pp. 762-772, May 1997.

[3] M. McClure and L.Carin, "Matched pursuits with a wave-based dictionary," accepted for publication in the *IEEE Trans. Signal Proc.*

[4] D. Kralj and L. Carin, "Time-domain characteristics of leaky-wave devices," *IEEE Microwave and Guided Wave Letts*, vol. 7, pp. 124-126, May 1997.

[5] M. McClure and L. Carin, "Wave-based matched-pursuits detection of submerged elastic targets," to appear in the *J. Acoustical Soc. Am.*

[6] L. Carin and V. Chen, "Adaptive time-frequency and model-based ISAR processing," submitted to *IEEE Trans. Antennas Prop.*

[7] M. McClure and L.Carin, "Matched pursuits with a wave-based dictionary," *IEEE Trans. Signal Proc.*, vol. 45, pp. 2912-2927, Dec. 1997.

[8] T. Dogaru and L. Carin, "Time-Domain Sensing of Targets Buried Under a Rough Air-Ground Interface", *IEEE Trans. Antennas Prop.*, March 1998.

[9] M. McClure and L. Carin, "Target detection with wave-based matching-pursuits dictionaries," submitted to the *IEEE Trans. Sig. Proc.*

[10] T. Dogaru, L. Collins, and L. Carin, "Optimal detection of a deterministic target buried under a randomly rough interface," submitted to *IEEE Trans. Antennas Propagat.*

VII. Patent Disclosures

None

VIII. Honors/ Awards

None